Inclusive Diffraction with sar*t*re

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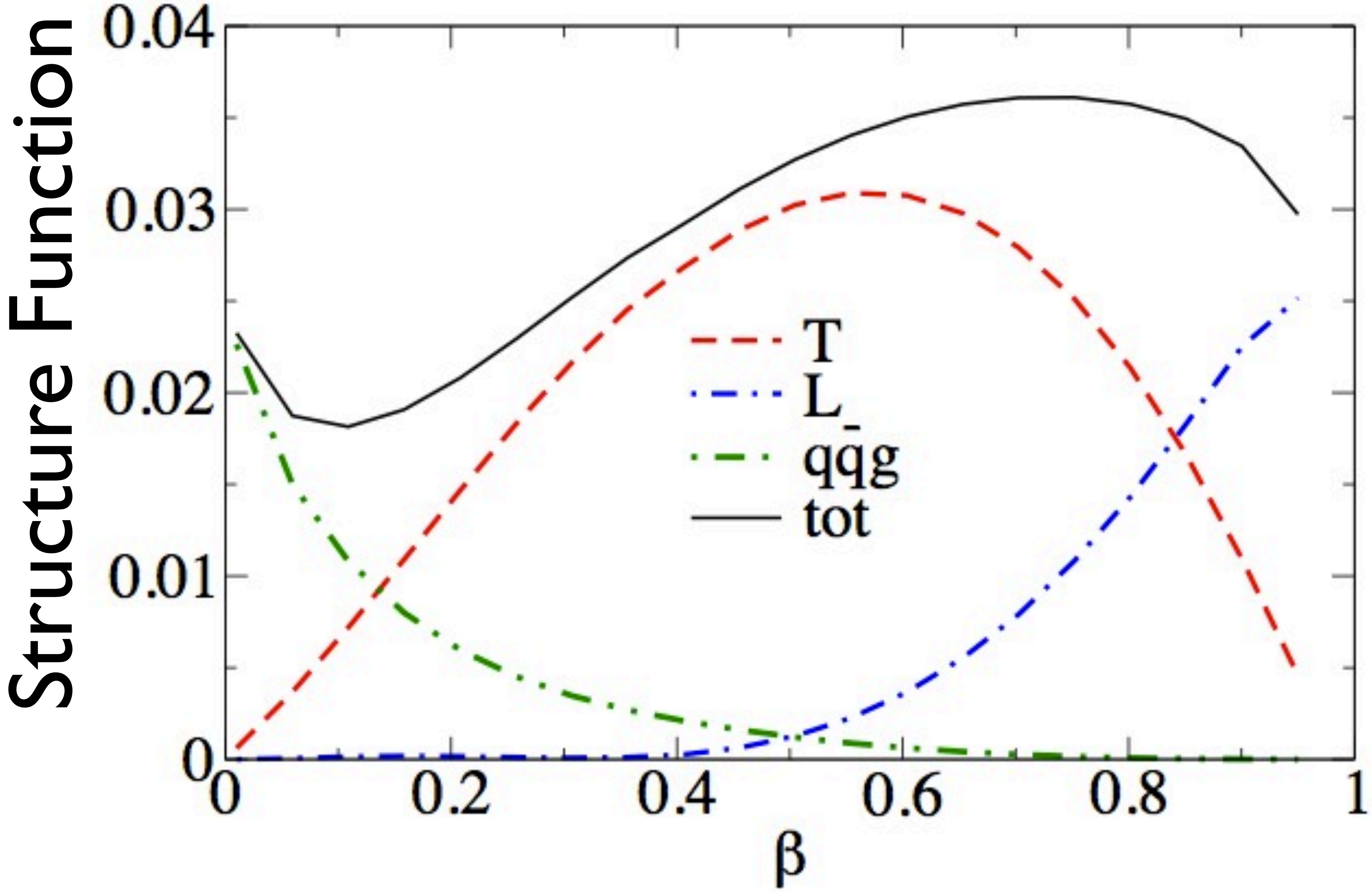
EIC Task Force Meeting

17 July 2013

Inclusive Diffraction

2 "Processes": $q\bar{q}$ and qqg



From KLMV

Start with $q\bar{q}$

Inclusive Diffraction

Start with $q\bar{q}$

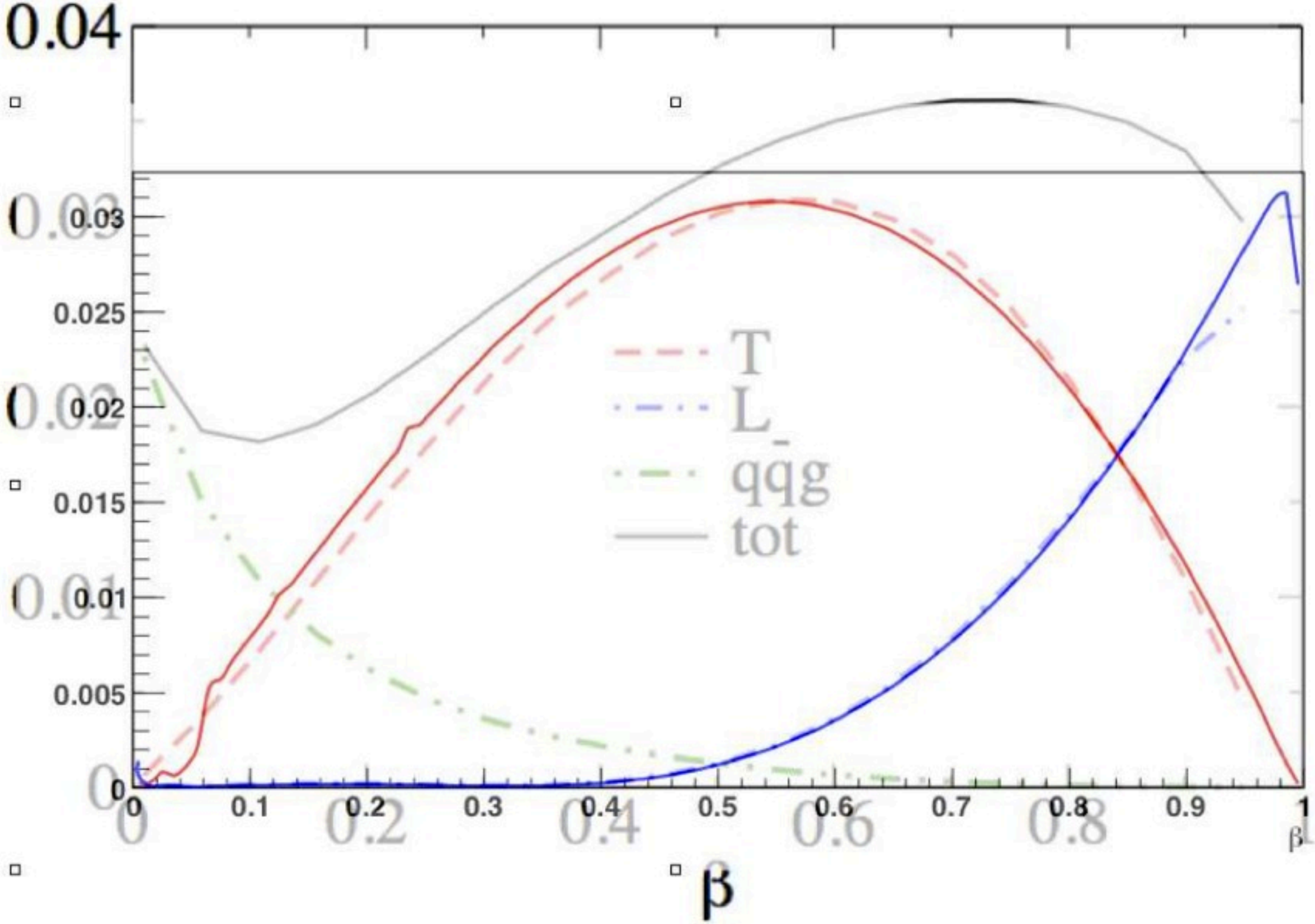
$$\Phi_n(\beta, Q^2, x_{I\!P}, z) = \int \mathrm{d}^2\mathbf{b} \left| \int \mathrm{d}r\ r K_n(\epsilon r) J_n(\kappa r) \frac{\mathrm{d}\sigma_{q\bar{q}}}{\mathrm{d}^2\mathbf{b}}(\mathbf{b}, r, x_{I\!P}) \right|^2$$

$$\frac{\mathrm{d}\sigma_T^{\gamma * p \to Xp}}{\mathrm{d}\beta} = \frac{N_C Q^2 \alpha_{\mathrm{em}}}{4\pi\beta^2} \sum_f e_f^2 \int_{z_0}^{1/2} \mathrm{d}z\ z(1-z) \left[\epsilon^2(z^2 + (1-z)^2)\Phi_1 + m_f^2 \Phi_0\right]$$

$$\frac{\mathrm{d}\sigma_L^{\gamma * p \to Xp}}{\mathrm{d}\beta} = \frac{N_C Q^4 \alpha_{\mathrm{em}}}{\pi\beta^2} \sum_f e_f^2 \int_{z_0}^{1/2} \mathrm{d}z\ z^3(1-z)^3 \Phi_0$$

$$\epsilon^2 = z(1-z)Q^2 + m_f^2$$
$$\kappa^2 = z(1-z)M_X^2 - m_f^2$$
$$M_X^2 = Q^2\left(\frac{1-\beta}{\beta}\right)$$

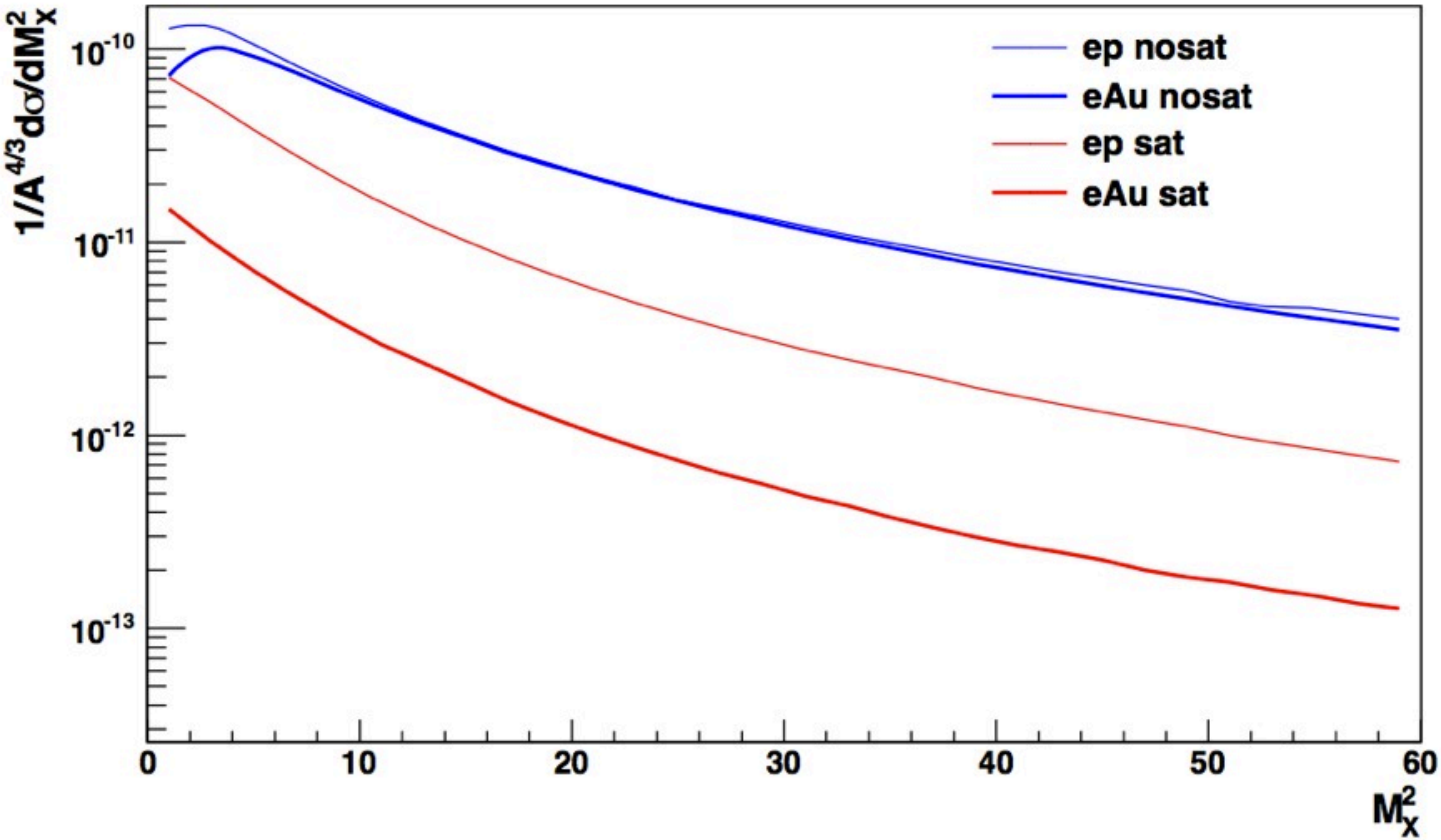
Step 1: reproduce KMLMV



bSat, bNonSat and Heavy Ions

bNonSat:

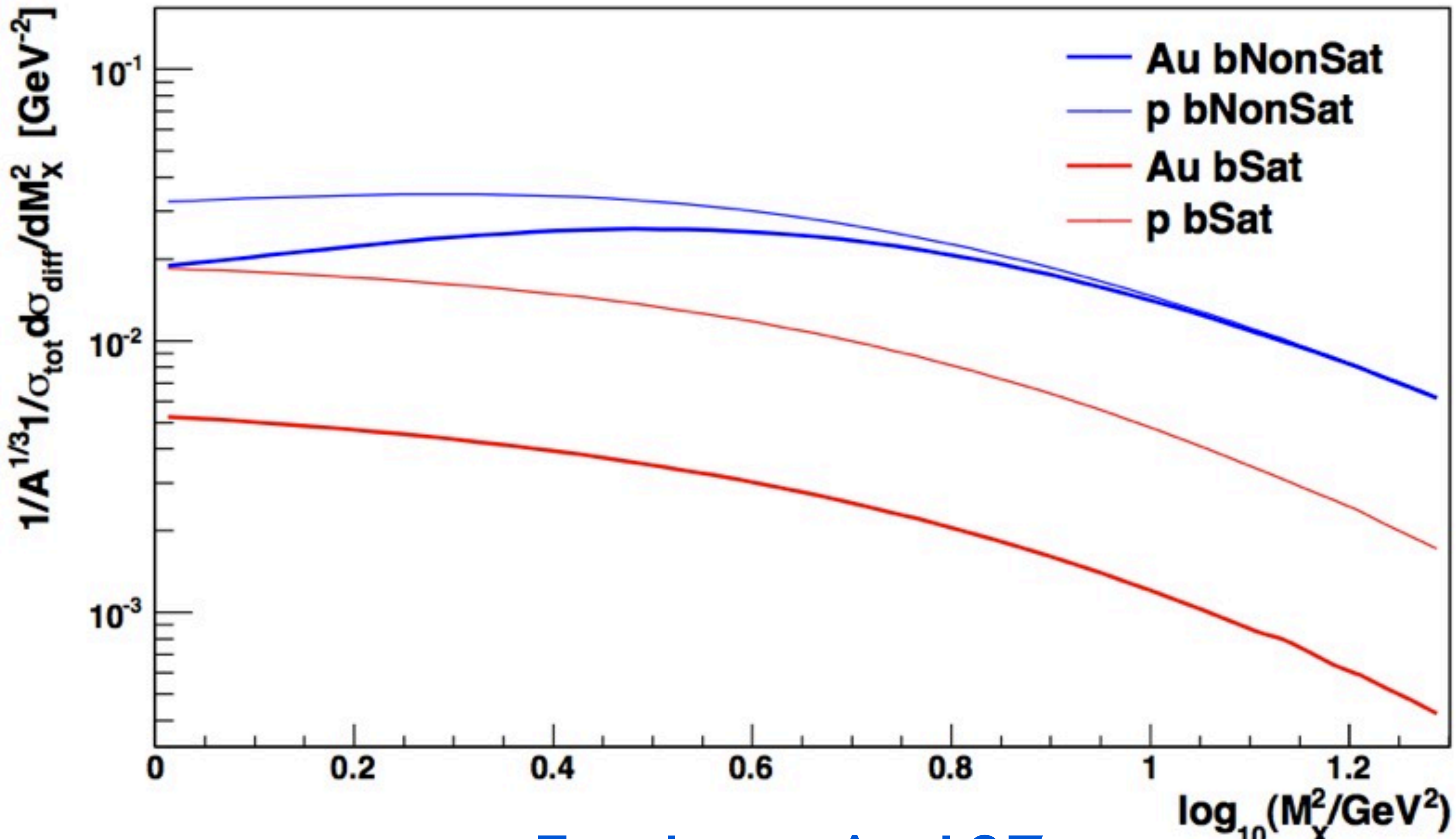
Diffractive cross-section scales like $A^{4/3}$



bSat, bNonSat and Heavy Ions

bNonSat:

Diffractive/total cross-section scales like $A^{1/3}$

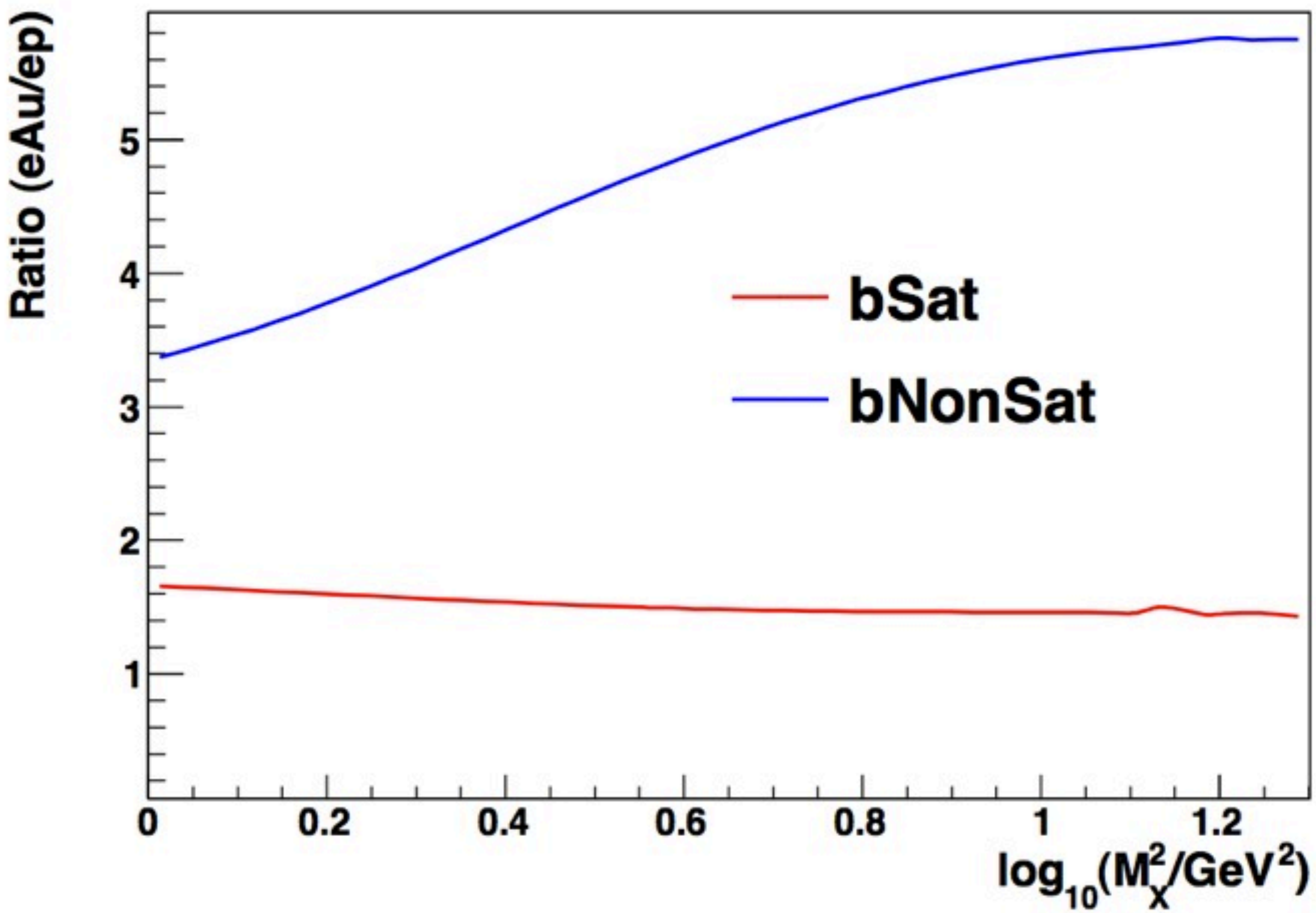


For large A=197

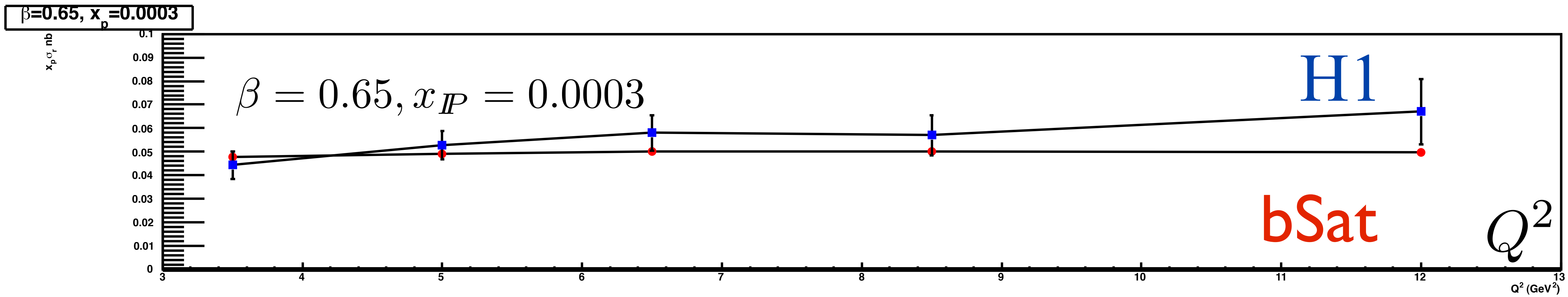
diffractive cross-section > total cross-section!

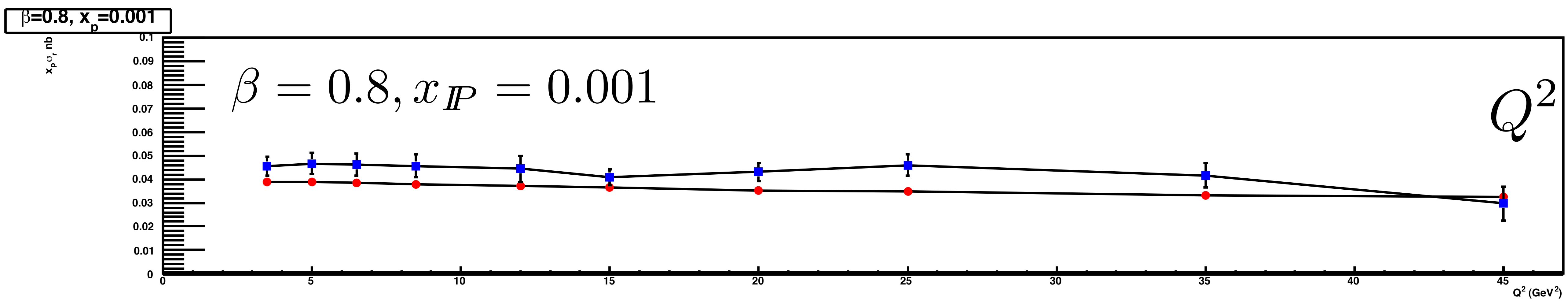
bSat, bNonSat and Heavy Ions

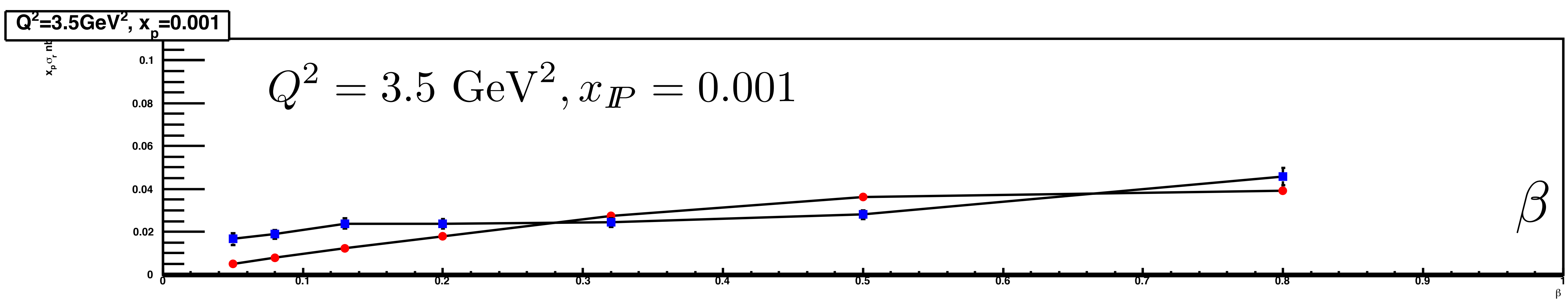
Reproducing the M_X plot in White Paper



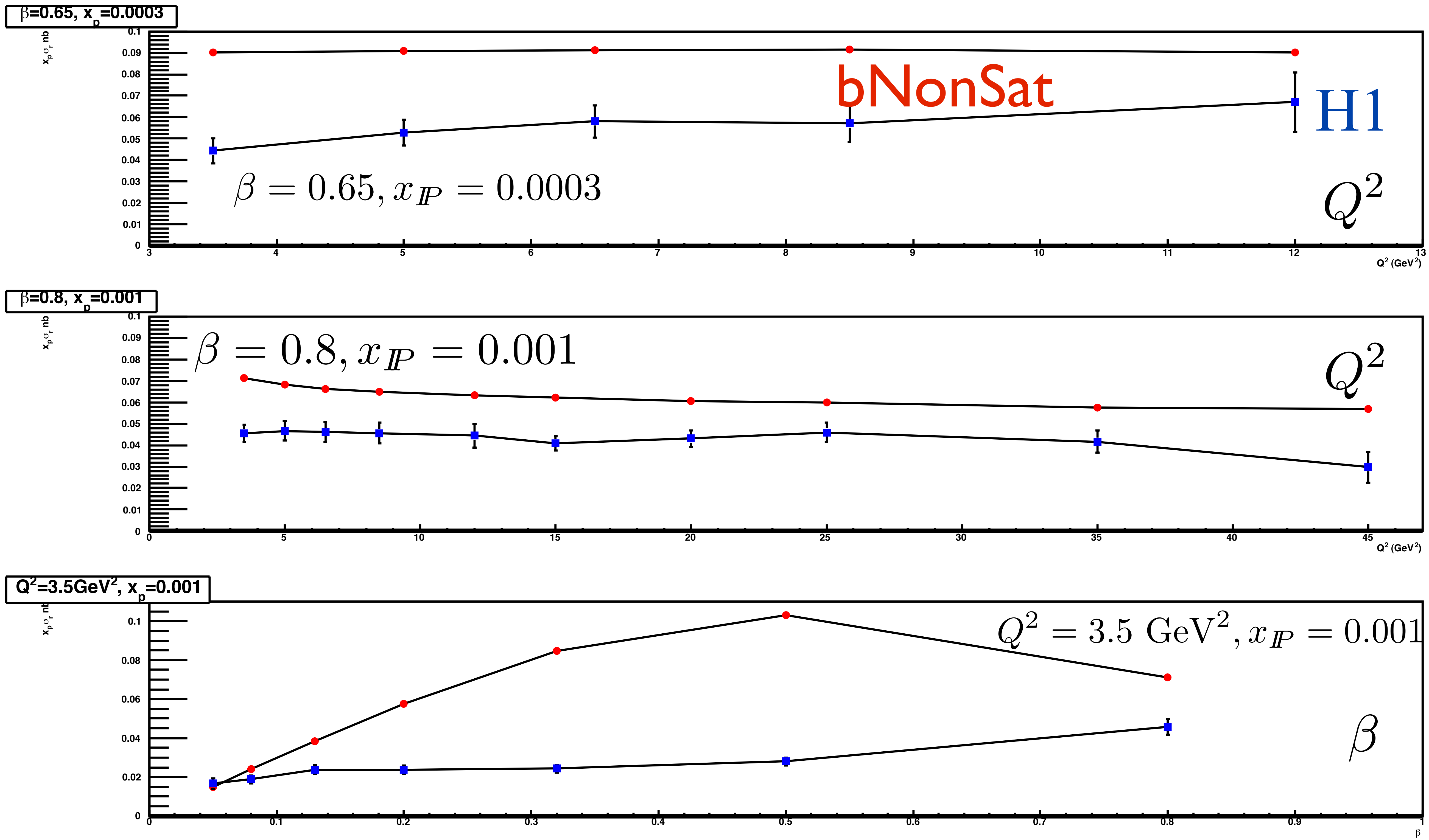
HERA data σ_r H1





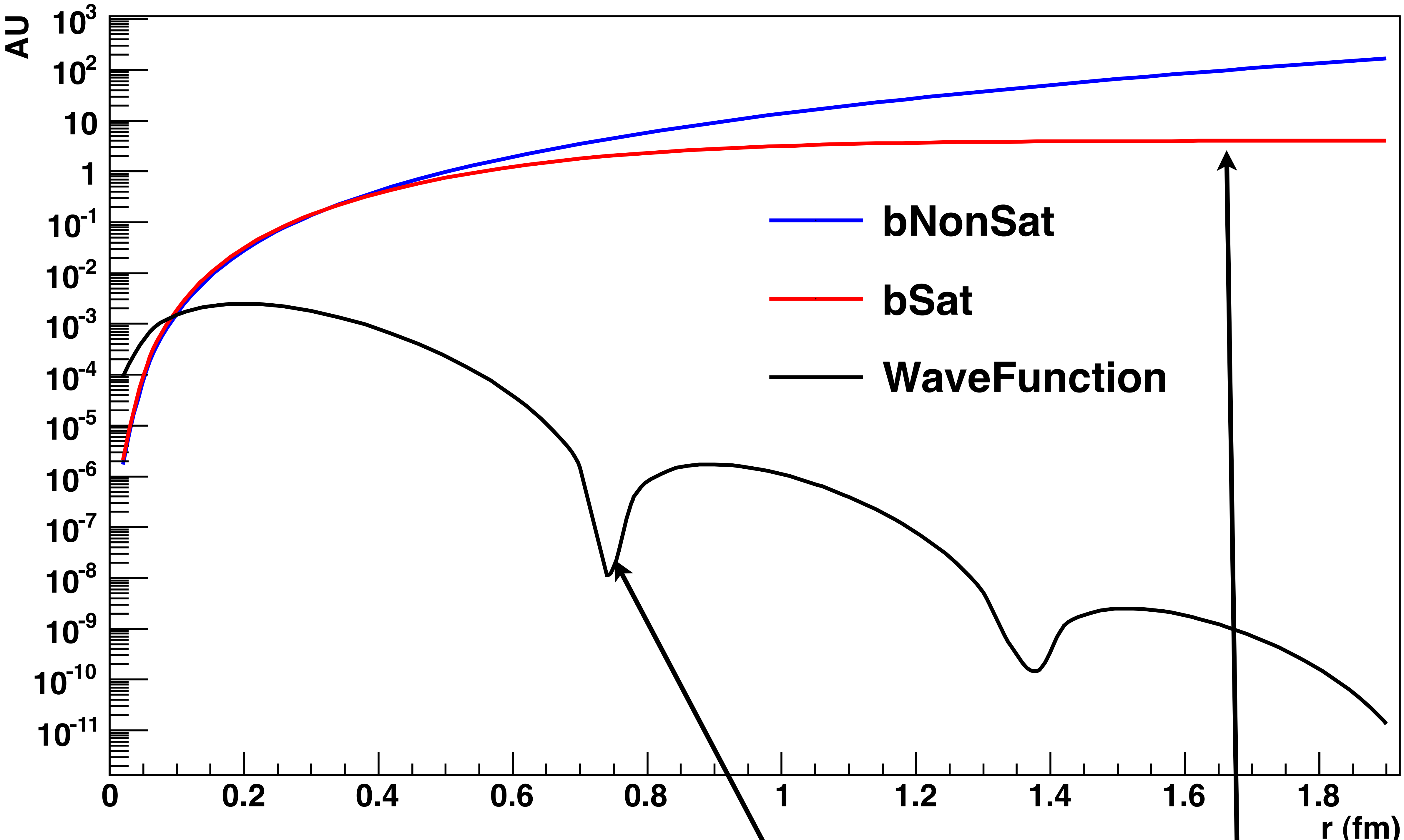


HERA data σ_r H1



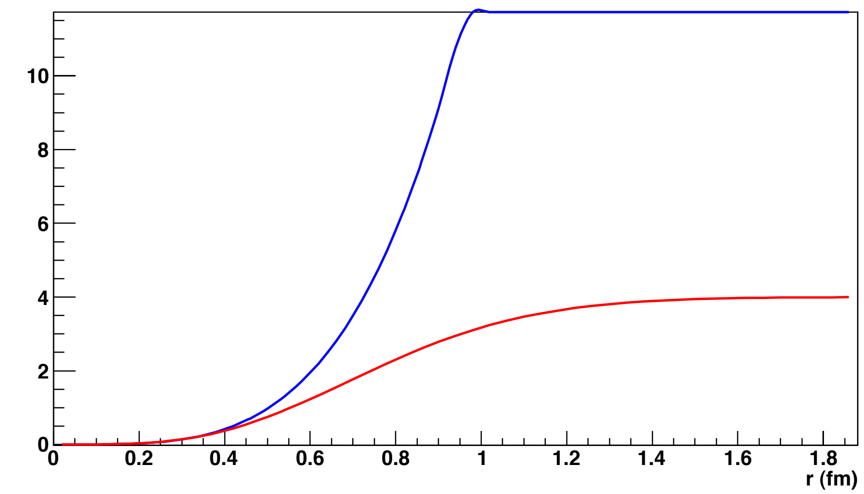
Thursday, July 18, 2013

bSat, bNonSat and Heavy Ions

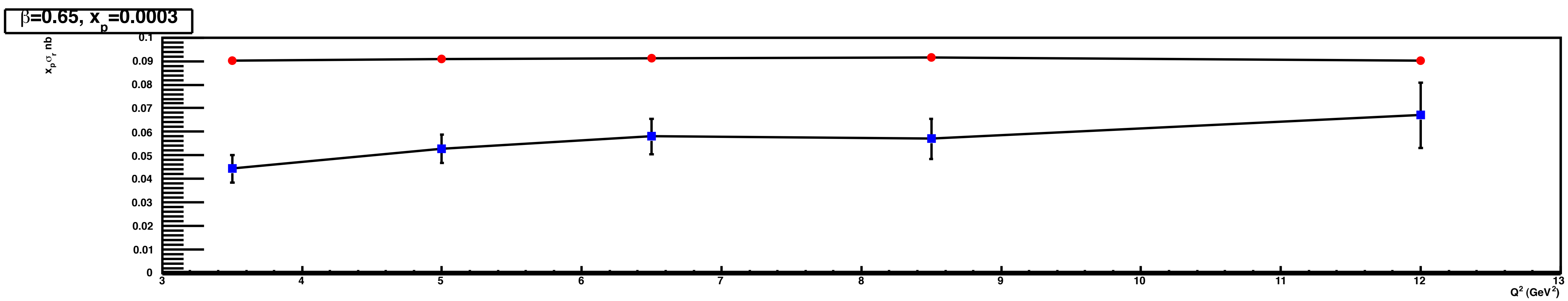


$$\Phi_n(\beta, Q^2, x_{I\!P}, z) = \int \mathrm{d}^2\mathbf{b} \left| \int \mathrm{d}r\ r K_n(\epsilon r) J_n(\kappa r) \frac{\mathrm{d}\sigma_{q\bar{q}}}{\mathrm{d}^2\mathbf{b}}(\mathbf{b}, r, x_{I\!P}) \right|^2$$

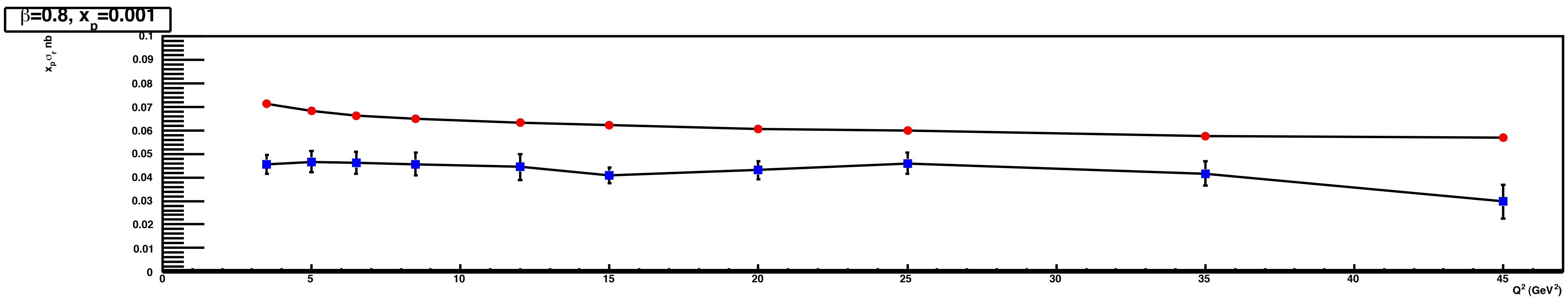
$r_{cut}=\infty$



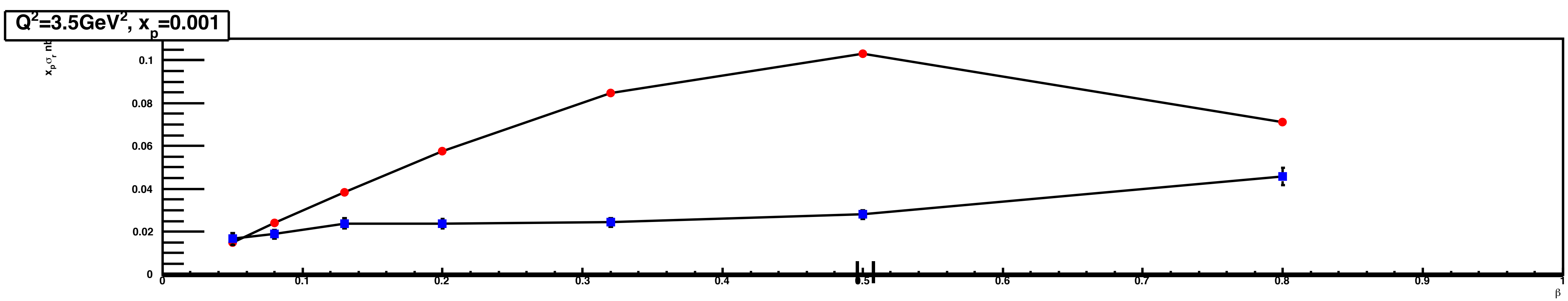
r (fm)



β=0.65, x_p=0.0003
$x_p\sigma_r$ nb
Q^2 (GeV^2)

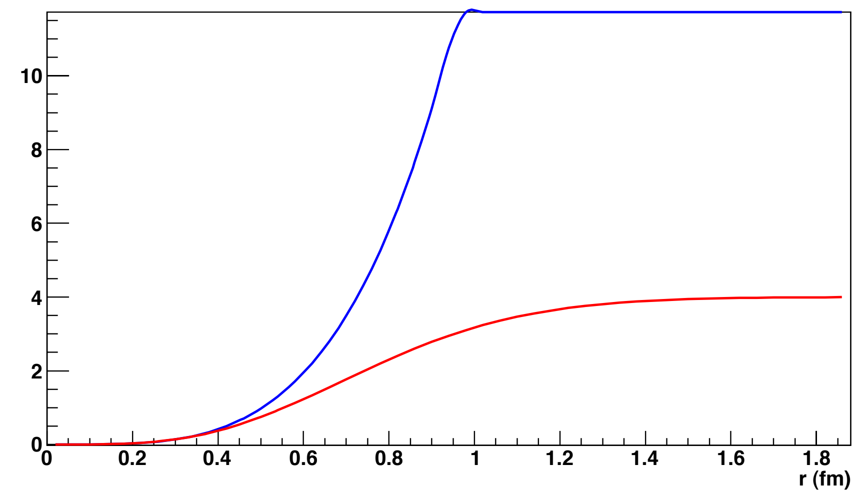


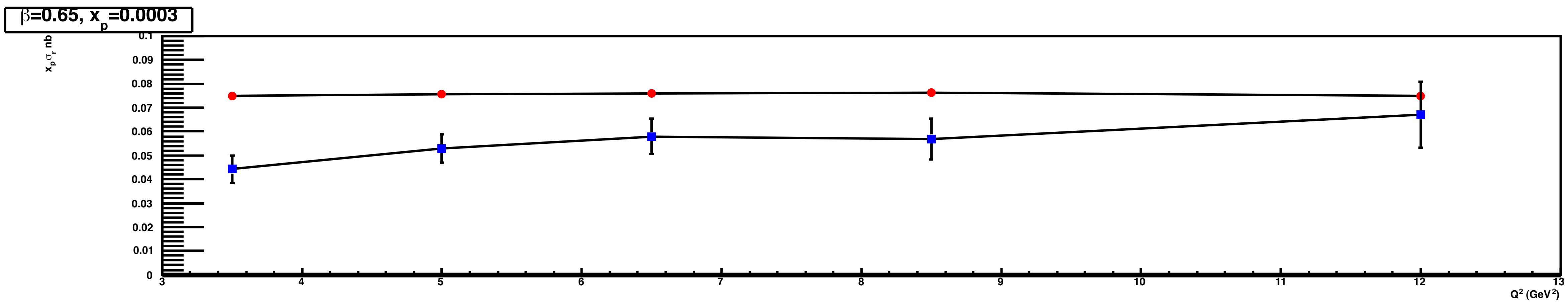
β=0.8, x_p=0.001
$x_p\sigma_r$ nb
Q^2 (GeV^2)

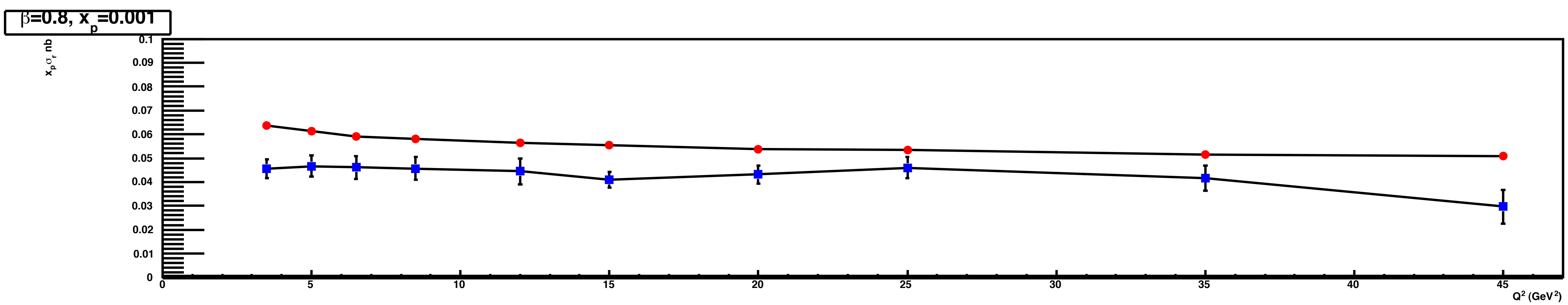


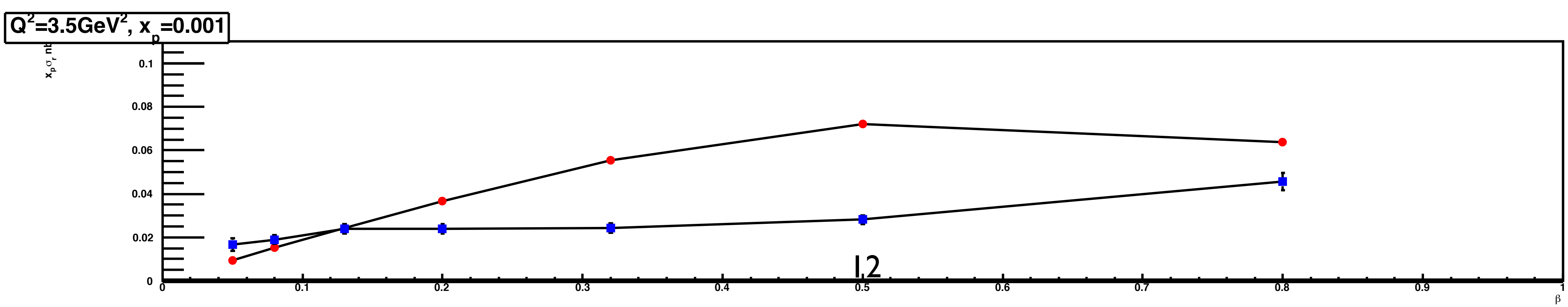
Q^2=3.5GeV^2, x_p=0.001
$x_p\sigma_r$ nb
β

r_{cut}=2.1 *fm*

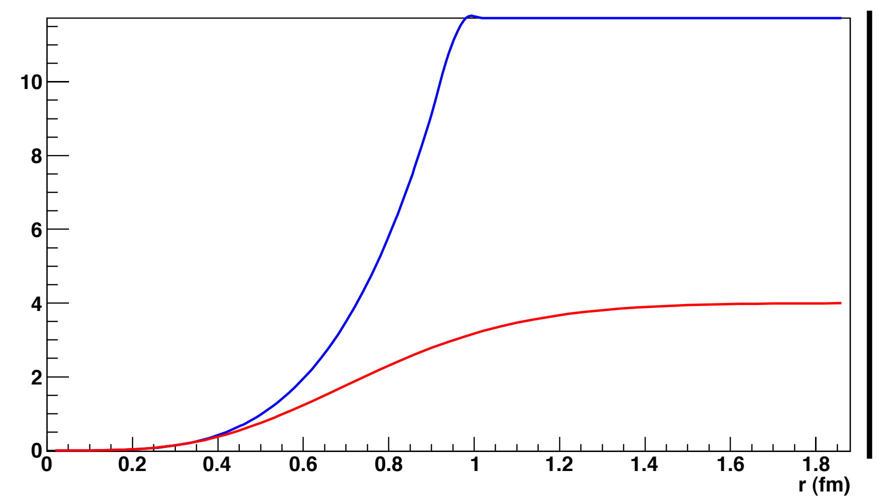








r_{cut}=1.9 fm



10
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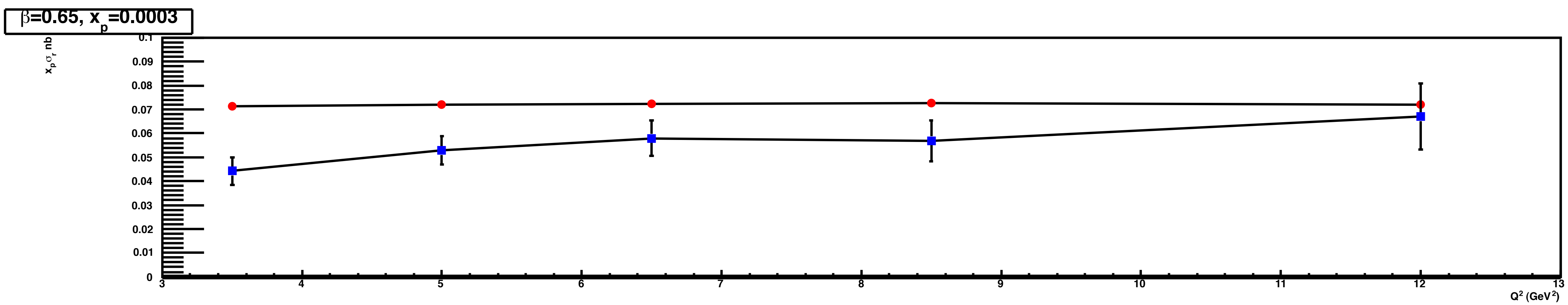
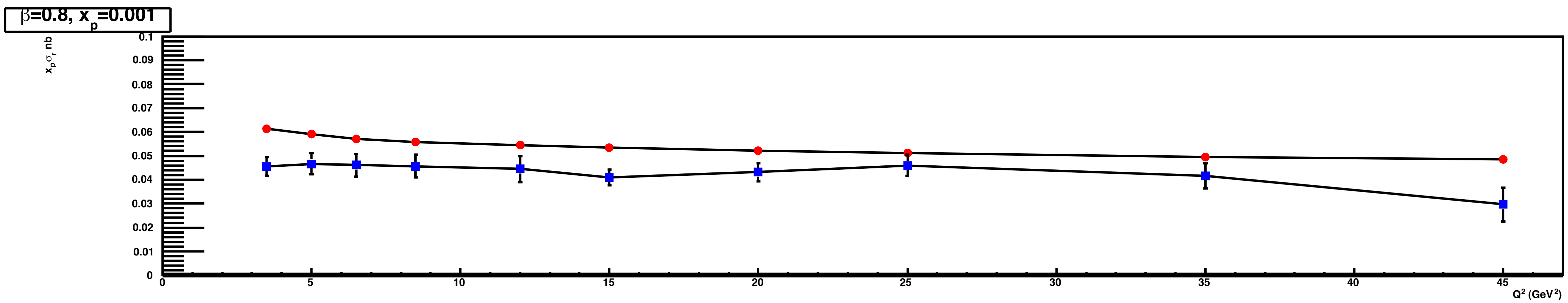
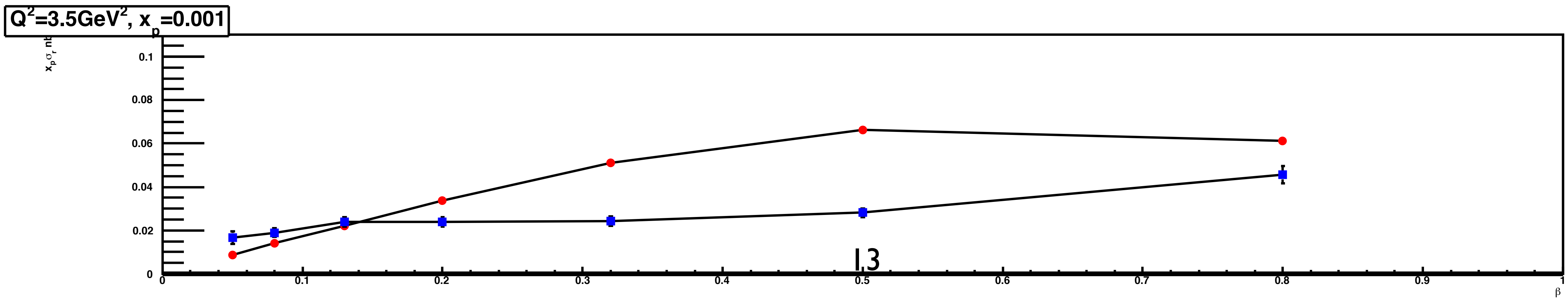
0 0.2 0.4 0.6 0.8 1 1.2 1.4 1.6 1.8
r (fm)



β=0.65, x_p=0.0003
x_p σ_r nb
Q² (GeV²)

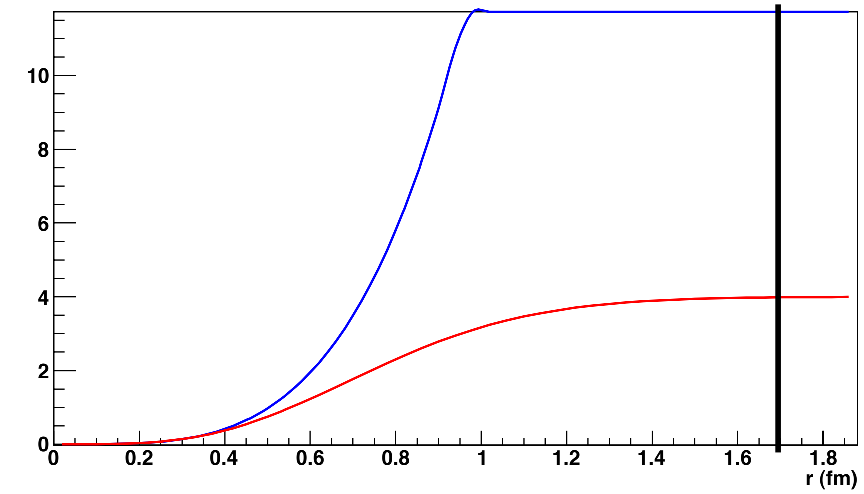


β=0.8, x_p=0.001
x_p σ_r nb
Q² (GeV²)



Q²=3.5GeV², x_p=0.001
x_p σ_r nb
β

r_{cut}=*1.7 fm*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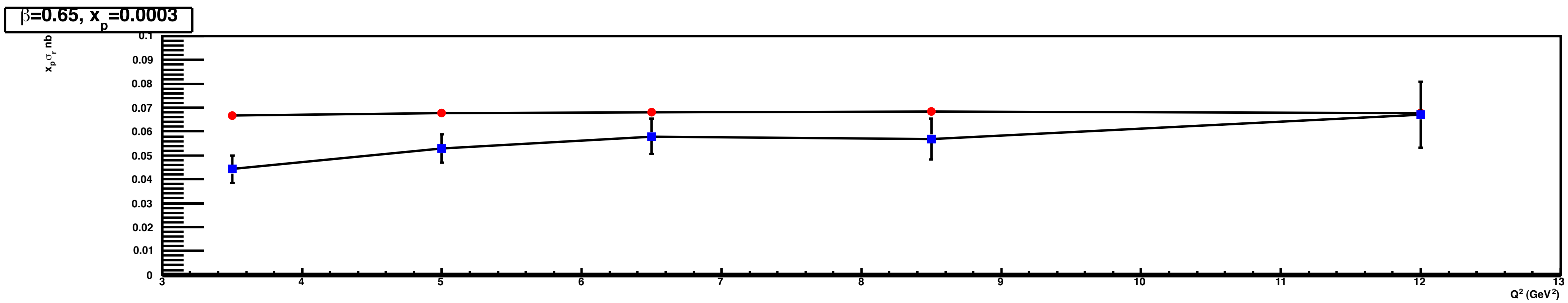
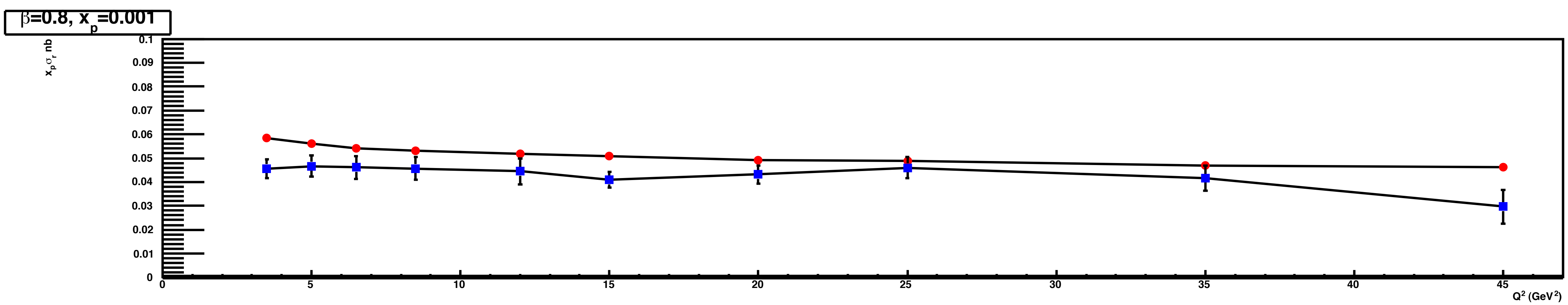
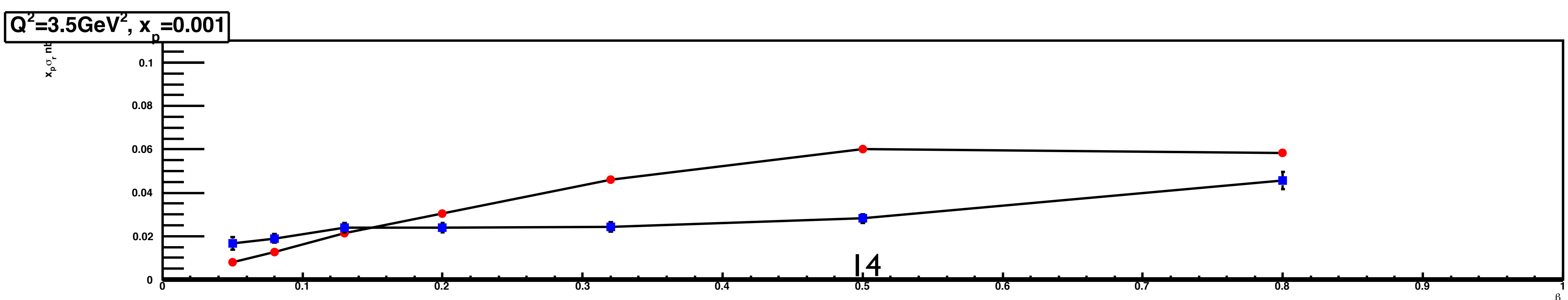
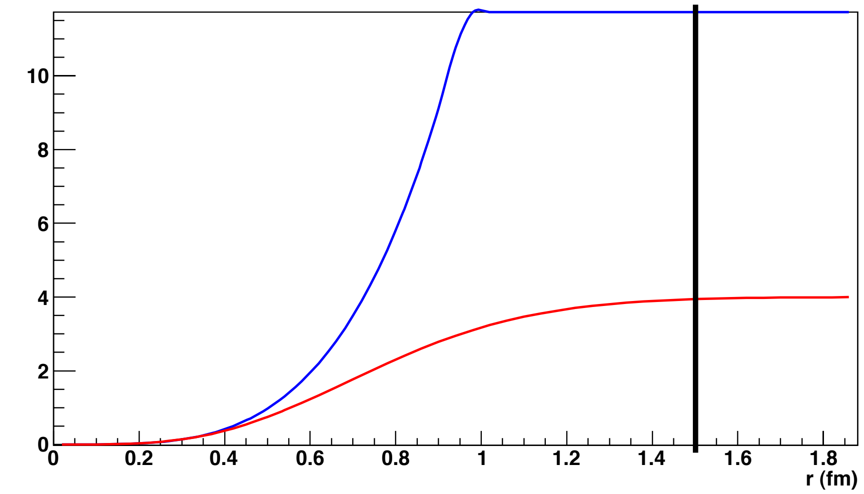
1.6
1.8
r (fm)

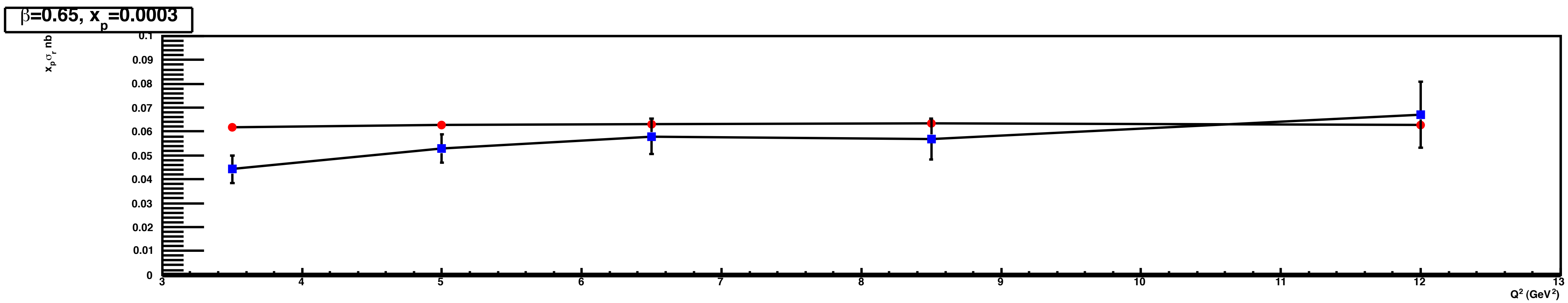

β=0.65, x_p=0.0003
$x_p\sigma_r$ nb
Q² (GeV²)

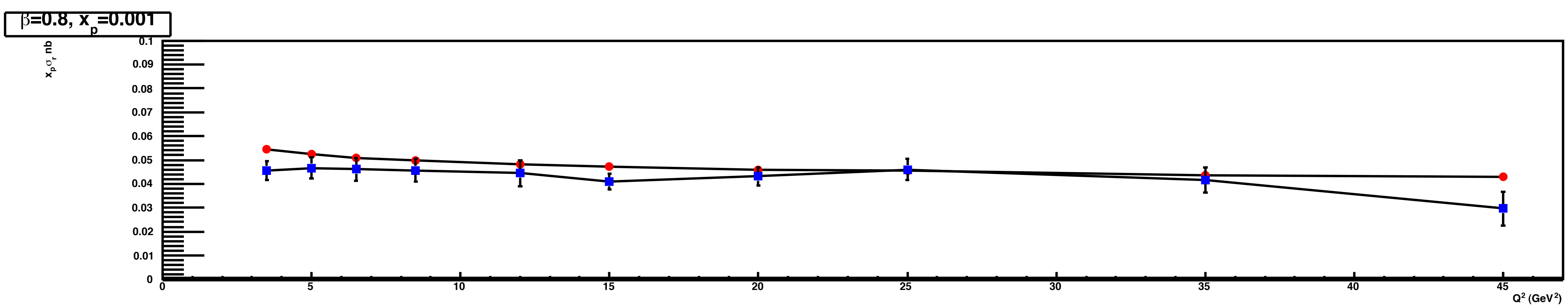

β=0.8, x_p=0.001
$x_p\sigma_r$ nb
Q² (GeV²)

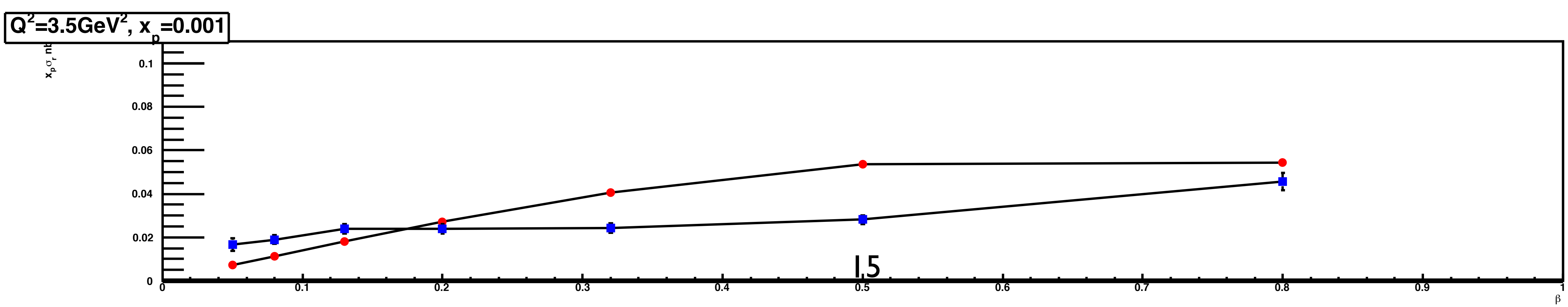

Q²=3.5GeV², x_p=0.001
$x_p\sigma_r$ nb
β

r_{cut}=*1.5 fm*

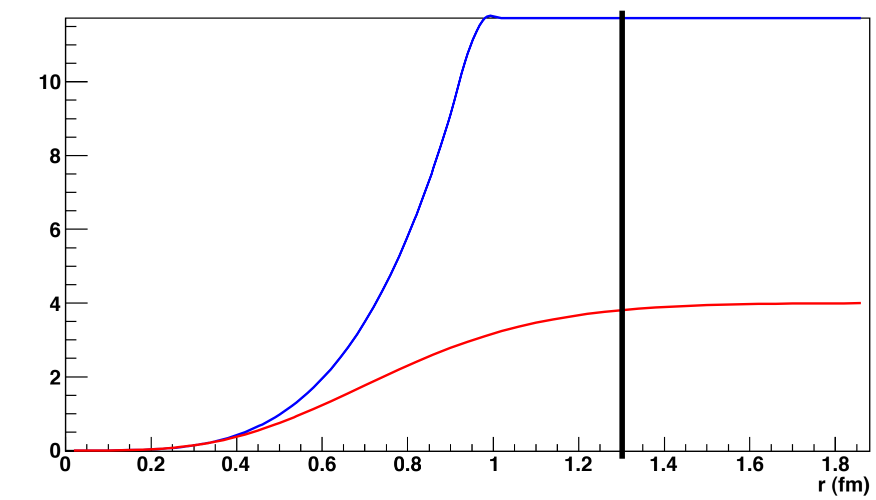

r (fm)


β=0.65, x_p=0.0003
x_p σ_r nb
Q² (GeV²)

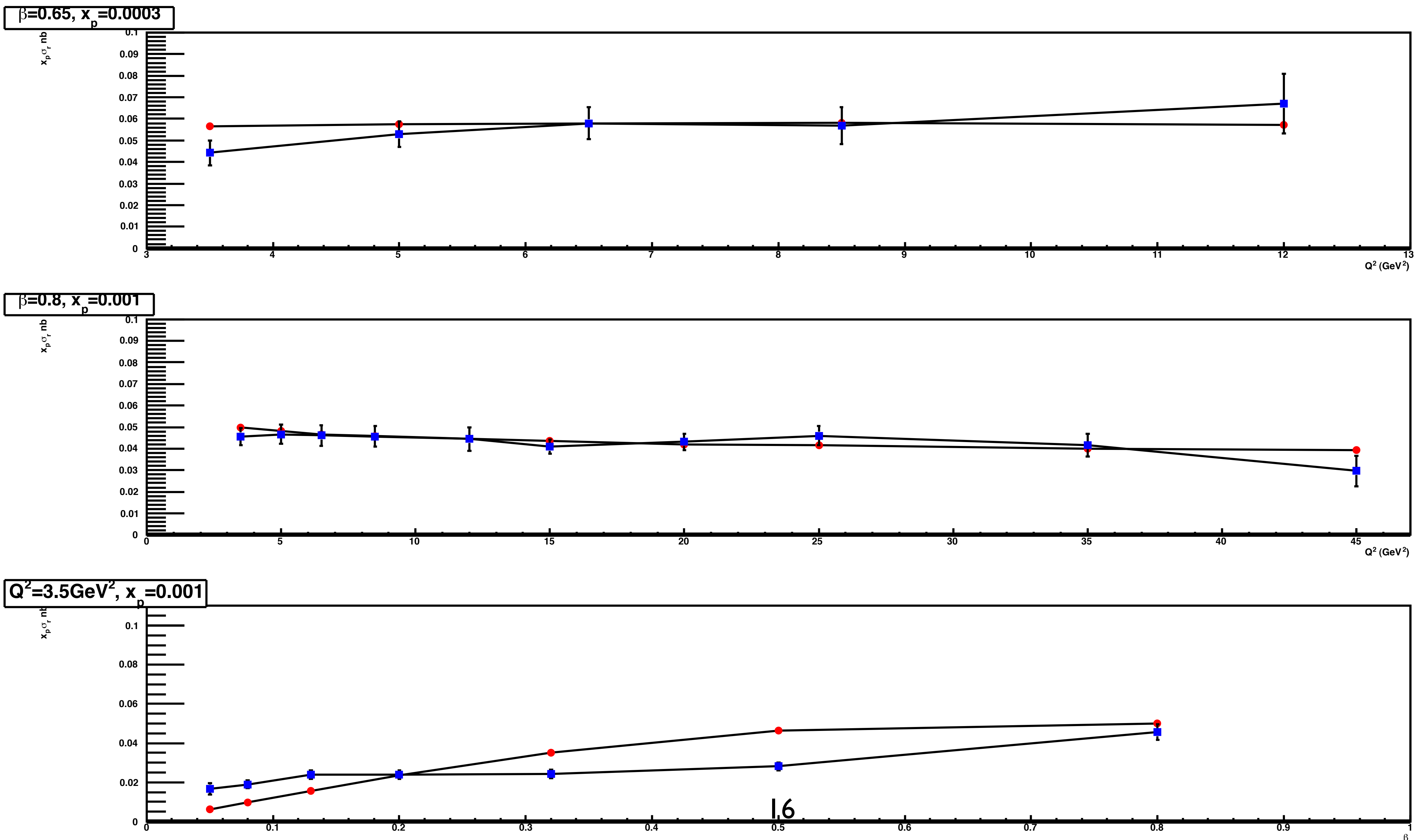

β=0.8, x_p=0.001
x_p σ_r nb
Q² (GeV²)


Q²=3.5GeV², x_p=0.001
x_p σ_r nb
β

r_{cut}=1.3 fm

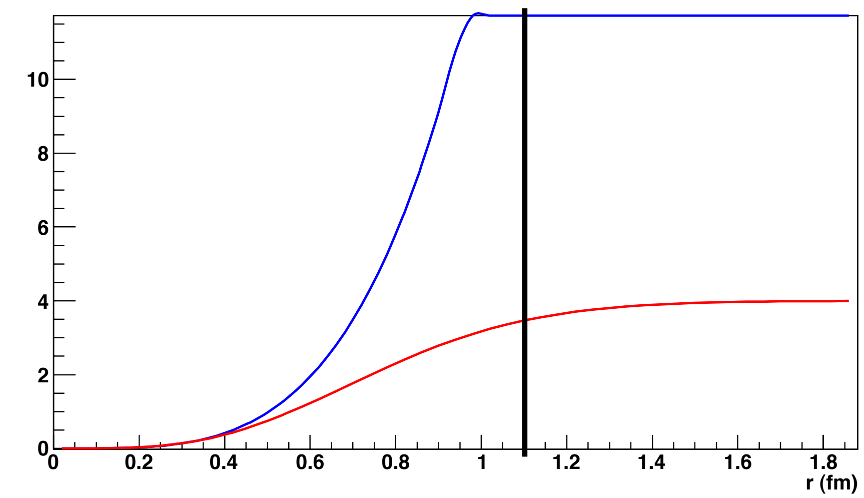


r (fm)



β=0.65, x_p=0.0003
$x_p\sigma_r$ nb
Q^2 (GeV^2)
β=0.8, x_p=0.001
$x_p\sigma_r$ nb
Q^2 (GeV^2)
Q^2=3.5GeV^2, x_p=0.001
$x_p\sigma_r$ nb
β

r_{cut}= *1.1 fm*



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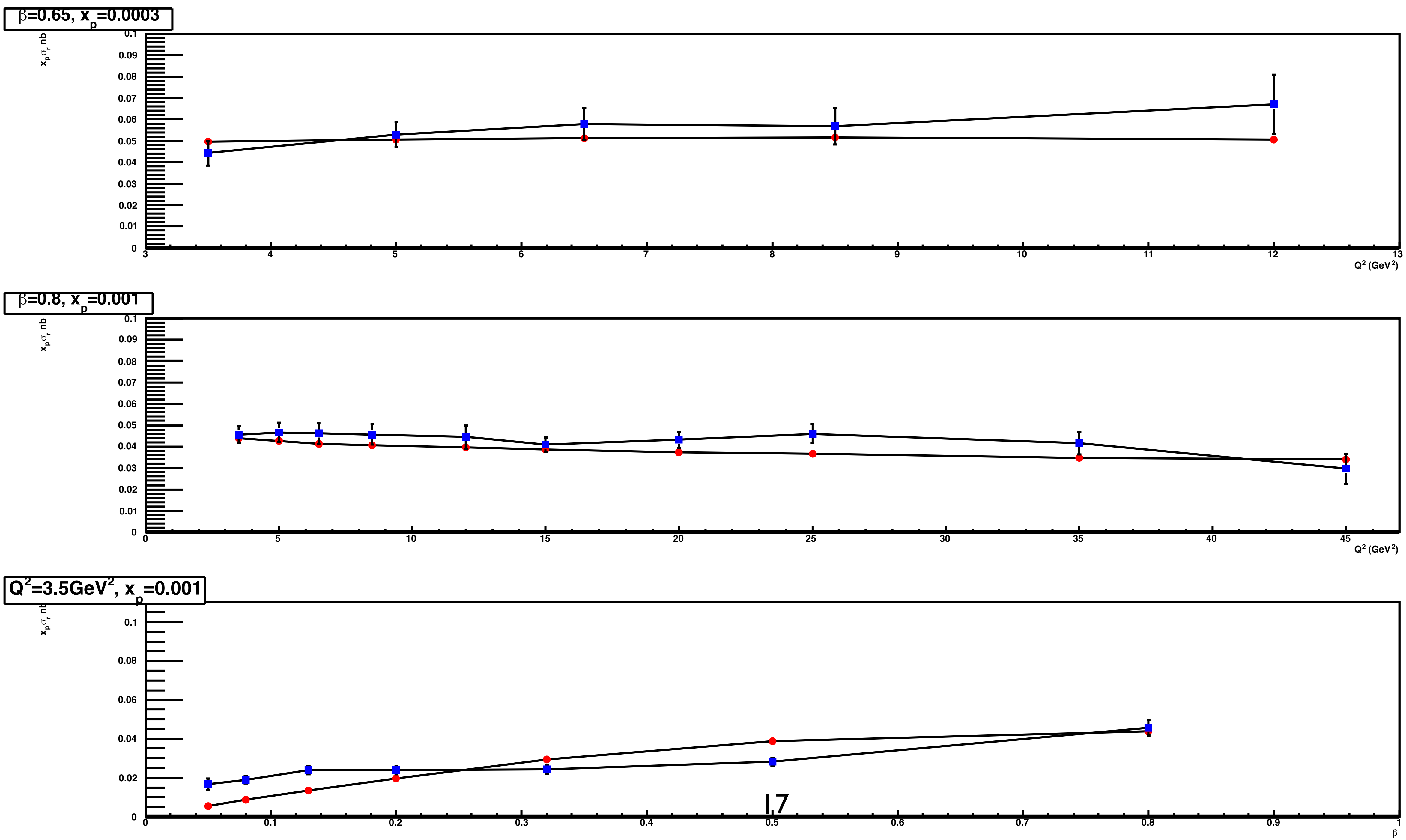
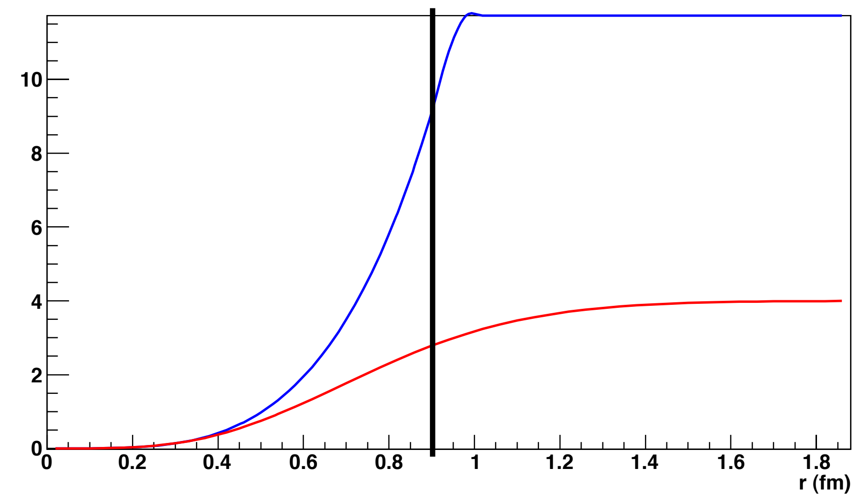
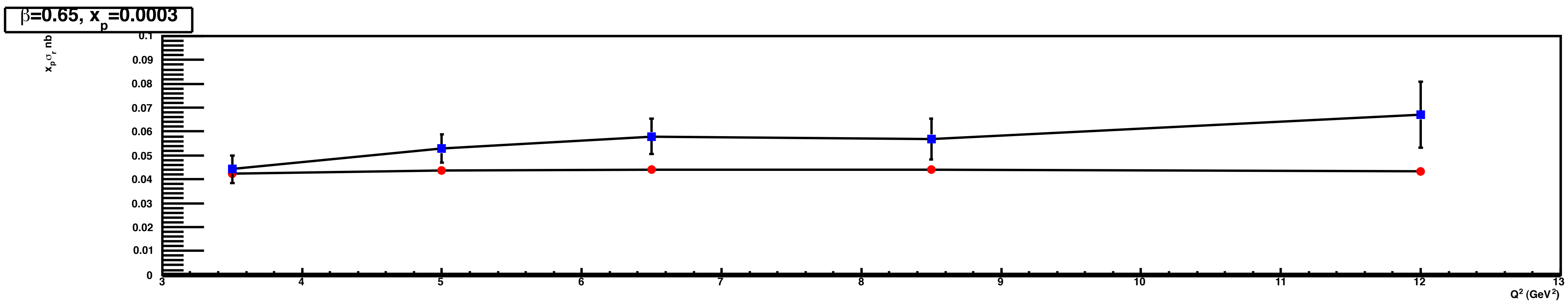
1.8
r (fm)

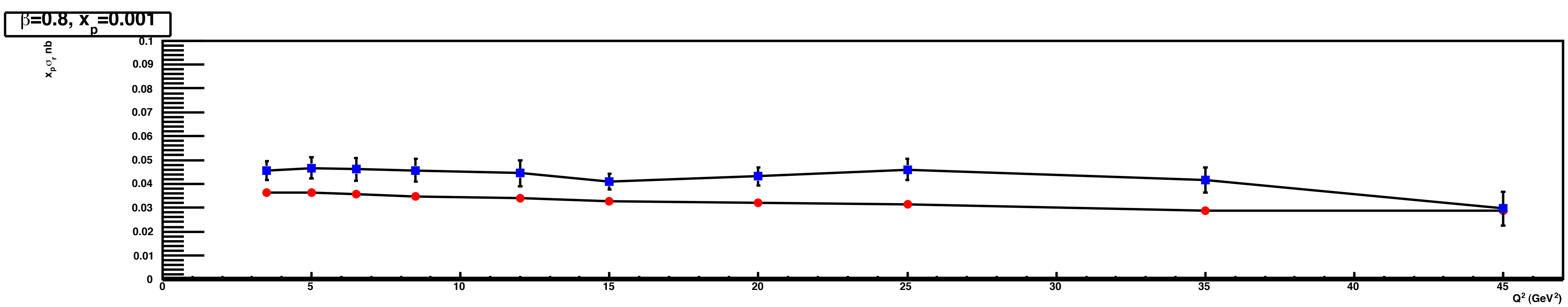


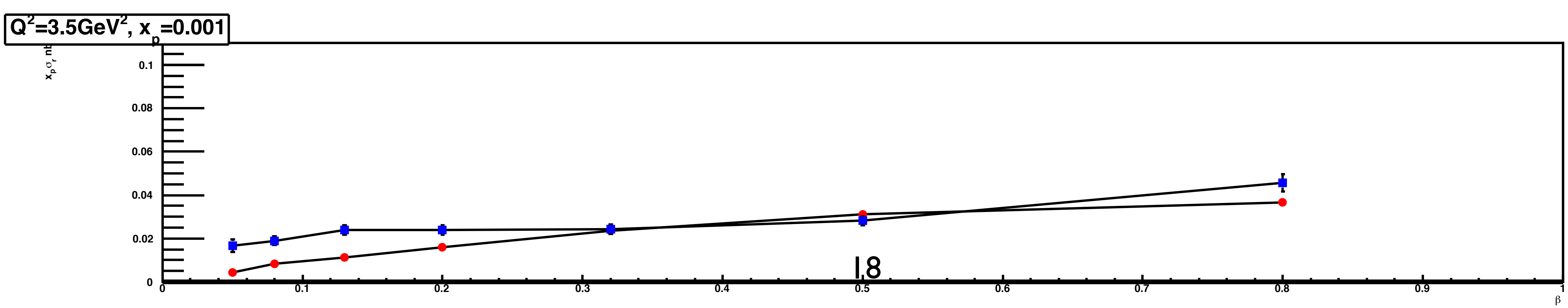
β=0.65, x_p =0.0003
x_p σ_r nb
Q² (GeV²)
β=0.8, x_p =0.001
x_p σ_r nb
Q² (GeV²)
Q²=3.5GeV², x_p =0.001
x_p σ_r nb
β

r_{cut}=0.9 fm


r (fm)

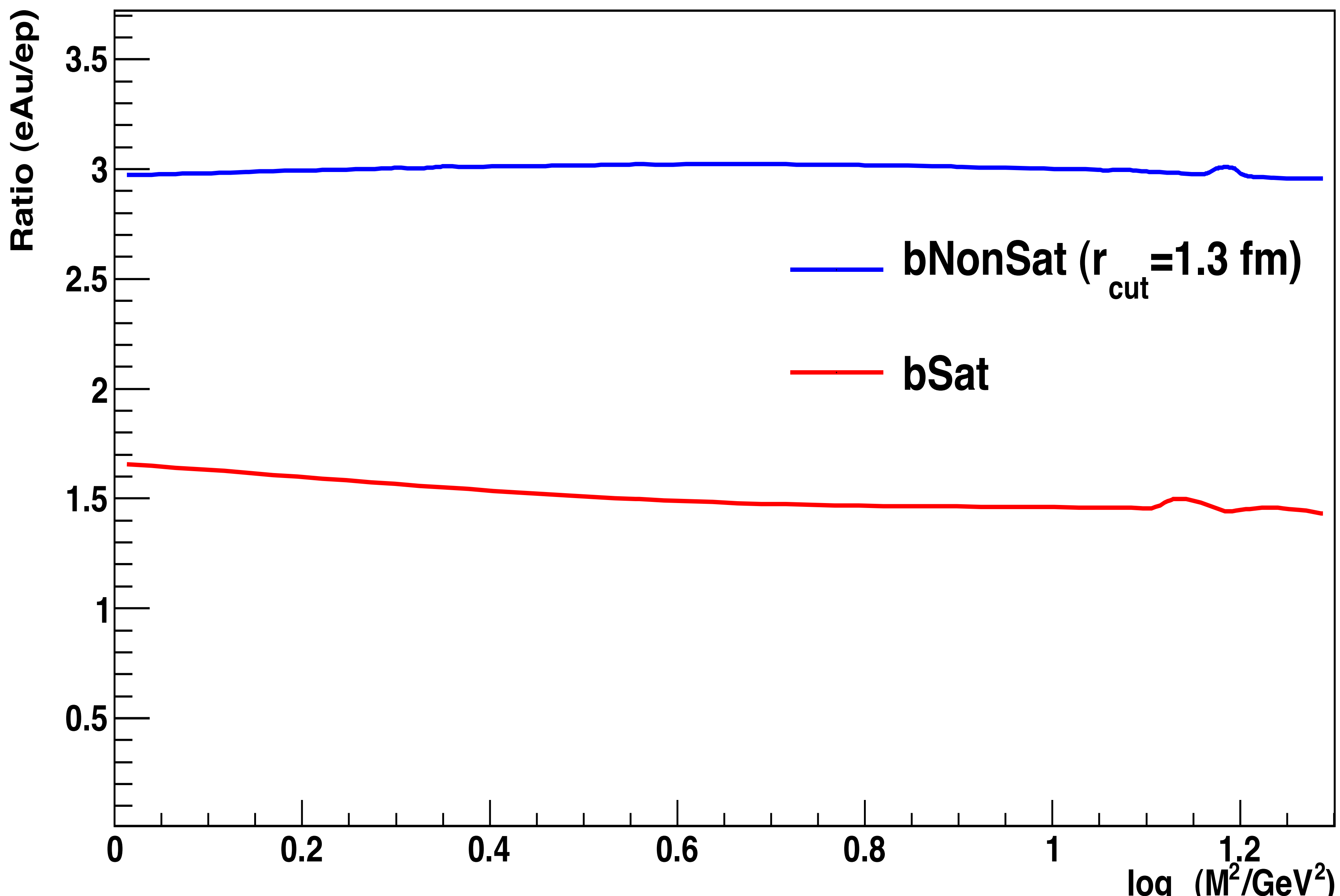

β=0.65, x_p=0.0003
x_p σ_r nb
Q² (GeV²)


β=0.8, x_p=0.001
x_p σ_r nb
Q² (GeV²)


Q²=3.5GeV², x_p=0.001
x_p σ_r nb
β

bSat, bNonSat and Heavy Ions

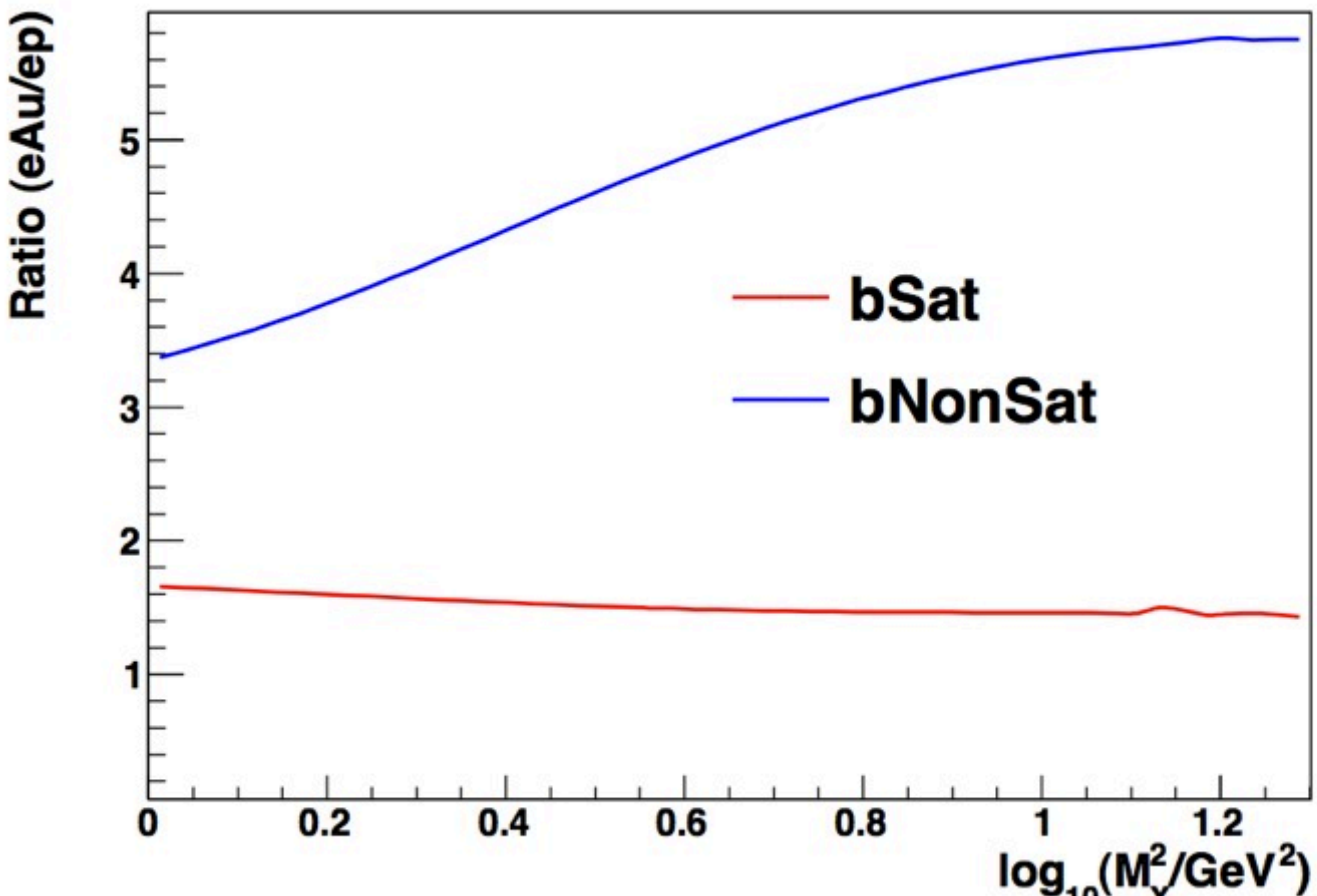
Reproducing the M_X plot in White Paper



However, no reason r_{cut} should not be A-dependent to describe data.

bSat, bNonSat and Heavy Ions

Reproducing the M_X plot in White Paper



However, no reason r_{cut} should not be A-dependent to describe data.

Next Steps: Exclusive Final State

In order to generate exclusive final state, do as before!
Replace M_{VM} with M_X

No information on *t*, generate it from parametrisation:

ep: $$\mathcal{P}(t) \propto \int_{t_{\min}}^{0} e^{Bt}$$

eA: $$\mathcal{P}_{coh.}(t) \propto \int_{t_{\min}}^{0} \frac{4\pi R_0}{A\Delta^3} \frac{\sin(\Delta R_0) - \Delta R_0 \cos(\Delta R_0)}{1 + a^2\Delta^2}$$

$$\mathcal{P}_{inc.}(t) \propto \int_{t_{\min}}^{0} Ce^{B't}$$

Next Steps: Fragment dipole

Need to boost *qq* into their center-of -mass, information on z needed:

$$\frac{\mathrm{d}\sigma_{T,f}^{\gamma * p\rightarrow Xp}}{\mathrm{d}\beta \mathrm{d}z} = \frac{N_C Q^2 \alpha_{\mathrm{em}}}{4\pi\beta^2} e_f^2 z(1-z)\left[\epsilon^2(z^2+(1-z)^2)\Phi_1 + m_f^2\Phi_0\right]$$

$$\frac{\mathrm{d}\sigma_{L,f}^{\gamma * p\rightarrow Xp}}{\mathrm{d}\beta \mathrm{d}z} = \frac{N_C Q^4 \alpha_{\mathrm{em}}}{\pi\beta^2} e_f^2 z^3(1-z)^3\Phi_0$$

Decide flavour probabilistically:
generate event with sum of flavours,
and then weigh the different contributions

Feed this to JetSet.

Enough for a first release!

Next Steps

Add qqg dipole

Possibly:

Add Total and Incoherent diffraction, by averaging over nuclei

$$\frac{\mathrm{d}\Phi_n^{\mathrm{tot}}}{\mathrm{d}^2\mathbf{b}} = \left| \left\langle \int \mathrm{d}r \; r K_n(\epsilon r) J_n \kappa r \frac{\mathrm{d}\sigma_{q\bar{q}}}{\mathrm{d}^2\mathbf{b}} \right\rangle_\Omega \right|^2$$

Summary

Implemented qq cross-sections.

bSat reproduces previous publications and describes HERA data

bNonSat can be made into describing HERA data by introducing a "higher saturation"-parameter r_{cut}
There is no way of knowing what this parameter should be for heavy nuclei